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THE HEIGHT ATTAINED BY A WAVE AGAINST A SLOPING STRUCTURE

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The formulas of N. N. Dzhunkovskiy ("The Action of Wind Waves on Hydrotechnical Installations," 1940, and "Experimental Study of the Action of a Swell on Hydrotechnical Installations With Sloped Walls," Collection of Works of the Moscow Engineering Construction Institute imeni Kuybyshev, No 3, 1939) and B. A. Pyshkin (Meteorologiya i Gidrologiya, No 7/8, 1939; Morskoy Flot No 5, 1947) were proposed for calculating the height attained by a wave on a straight flat slope of an installation. The first of these, which is applicable to slopes with gradients from 1:1 to 1:4.0 has the form

$$H_0 \div 3.2\, KH\, tg\alpha \qquad (1)$$

where H_0 is the unknown height attained by the wave above the level of calm water; H is the height of the wave at a distance as it approaches the structure: α is the angle of inclination of the sloping edge of the installation to the horizon; K is a coefficient which depends upon the degree of roughness of this edge (according to Dzhunkovskiy, $K = 1.0$ for concrete and smooth pavement, and $K = 0.8$ for stone heaps).

Pyshkin's formula refers to slopes with inclinations from 1:1.0 to 1:6.0 and has the form

$$H_0 = \frac{0.565H}{ctg\alpha \sqrt{n}} \qquad (2)$$

where H_0, H, and α are as above, the unknown height attained by the wave, the height of the wave, and the angle of inclination of the sloping edge of the installation to the horizon, and n is the coefficient of roughness of this edge according to Ganil' and Cutter.

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These formulas were checked by the author of the present article in his MOONIIRF wave laboratory, which is shown in Figure 1 (see description of the laboratory in "New Wave-Producing Equipment of P. K. Bozhich's System," Vodnyy Transport, No 8, 1939). /Figure 1, a photograph, is not reproduced./

One hundred thirty-five experiments were made with slopes of 1:2.0, 1:2.5, and 1:3.0 which were covered with different types of stone paving as follows: (a) heaps of stone of various size with the weight of each stone 12-20 g, 40-60 g, 95-160 g, 190-310 g, and 320-540 g; (b) stone paving of the same dimensions; (c) concrete slab paving 50 x 50 x 20 mm and 100 x 100 x 10 mm.

The experiments were made using different stable wave regimes, with two-dimensional progressive waves from 100 to 170 mm high and 1.10 to 2.80 m long.

Results of the experiments are presented in the table and in Figure 2, where they are compared with the corresponding data calculated by formulas (1) and (2), using the following values:

(1) The value of K is 0.8 for stone heaps and 1.0 for concrete slabs as the author of formula (1) recommended, and an intermediate value K = 0.9 was selected for paving which had an average rough surface between the extremes of stone heaps and the slab pavings in the experiments which we conducted.

(2) The value n is 0.01 for concrete slab paving, 0.02 for pavement, and 0.04 for stone heaps.

This material shows that of the two analyzed formulas, the first (Dzhunkovskiy) gave results for all the inclinations and pavements of the slopes which were much closer to the experimental data than the second formula (Pyshkin). An analogous conclusion was made by the author of the present article when another experimental study was made earlier. The tendency of the values of H_0 to be higher when calculated according to formula (2) which is shown in Table 1 and Figure 2 has already been observed in literature by other authors. (See V. G. Andreyanov, "The Height Attained by a Wave on Installations," Meteorologiya i Gidrologiya, No 8, 1940.)

For all of these reasons it is preferable in all cases here covered by the experimental studies to use Dzhunkovskiy's formula. According to the materials presented above, formula (1) has the closest approximation of calculated values of H_0 to their experimental values for concrete slab pavings on a slope, while this formula gave somewhat higher values for H_0 in the case of pavement and stone heaps. These values, however, can approach the experimental by a slight decrease of the corresponding values of the coefficient K, i.e., by using lower values than those given above:

a) 1.1 times lower for pavement, i.e., by taking $K = \frac{0.9}{1.1} \infty 0.8$

b) 1.2 times lower for stone heaps, i.e., $K = \frac{0.8}{1.2} \infty 0.7$

The graphs corrected in this manner are shown in Figure 2 by broken lines.

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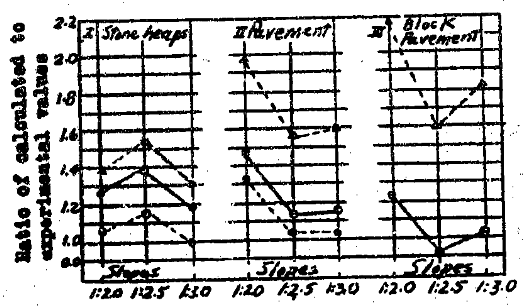
Table 1. Basic Data of Experimental Tests of Formulas (1) and (2)

Type of Stone Paving of the Slope	Average ratios of values of H_0 calculated by formula (1) to their experimental values			Average ratios of values of H_0 calculated by formula (2) to their experimental values		
	Slope 1:2.0	1:2.5	1:3.0	Slope 1:2.0	1:2.5	1:3.0
Stone heaps	1.27	1.39	1.18	1.38	1.54	1.30
Pavement	1.47	1.14	1.15	1.98	1.55	1.59
Slab pavement	1.24	0.92	1.03	2.19	1.60	1.83

Figure 2



Designations:

o——o according to Dzhunkovskiy
o- - -o the same, with corrected coefficient K
△- - -△ according to Pyshkin

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